NTIA Spectrum Monitoring

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Outline

- Motivation
- Boulder Wireless Test City (BWTC)
- Heterogeneous, distributed, persistent monitoring
- Conclusion

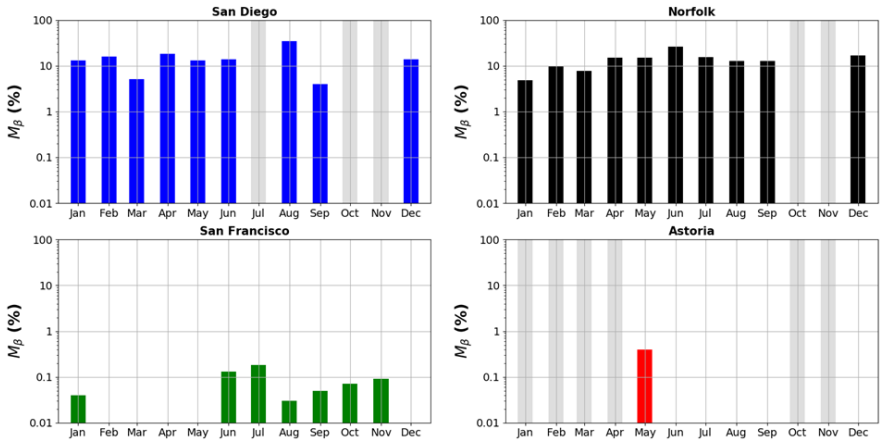
ITS History in Spectrum Measurement and Monitoring

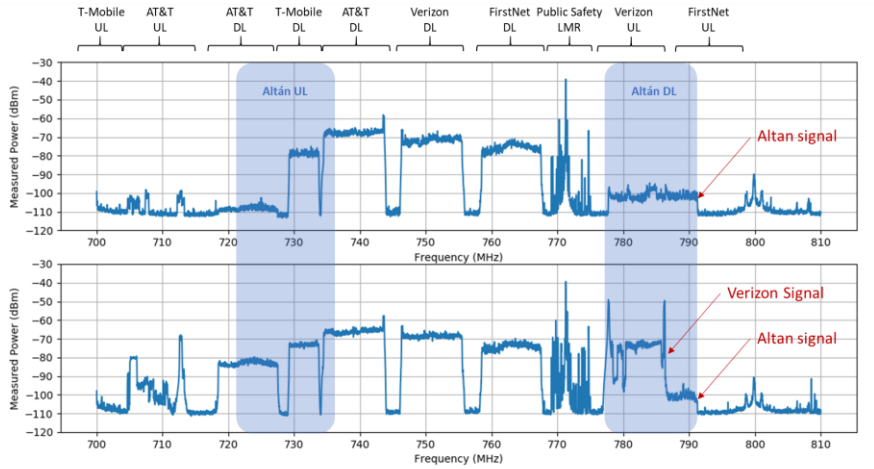
Commerce and NTIA systems since 1927:
(Clockwise from low-left)

- Radio measurement car, 1927
- RSMS-1, 1980
- RSMS-3, Angel Island
- RSMS-1
- RSMS-4
- NTIA suitcase system, Fort Irwin, 2000

Motivation

- Increasing demand for finite spectrum
- Congestion and dynamic usage of spectrum may lead to unintended interference/degradation
- Jamming and intentional interference has become cheaper and easier
- Wireless security lags behind cybersecurity
- Traditional monitoring approaches are not standardized and do not scale to the current and future challenges
- Value in persistent sensing
- Real-world wireless test environments are needed to develop advanced wireless technologies



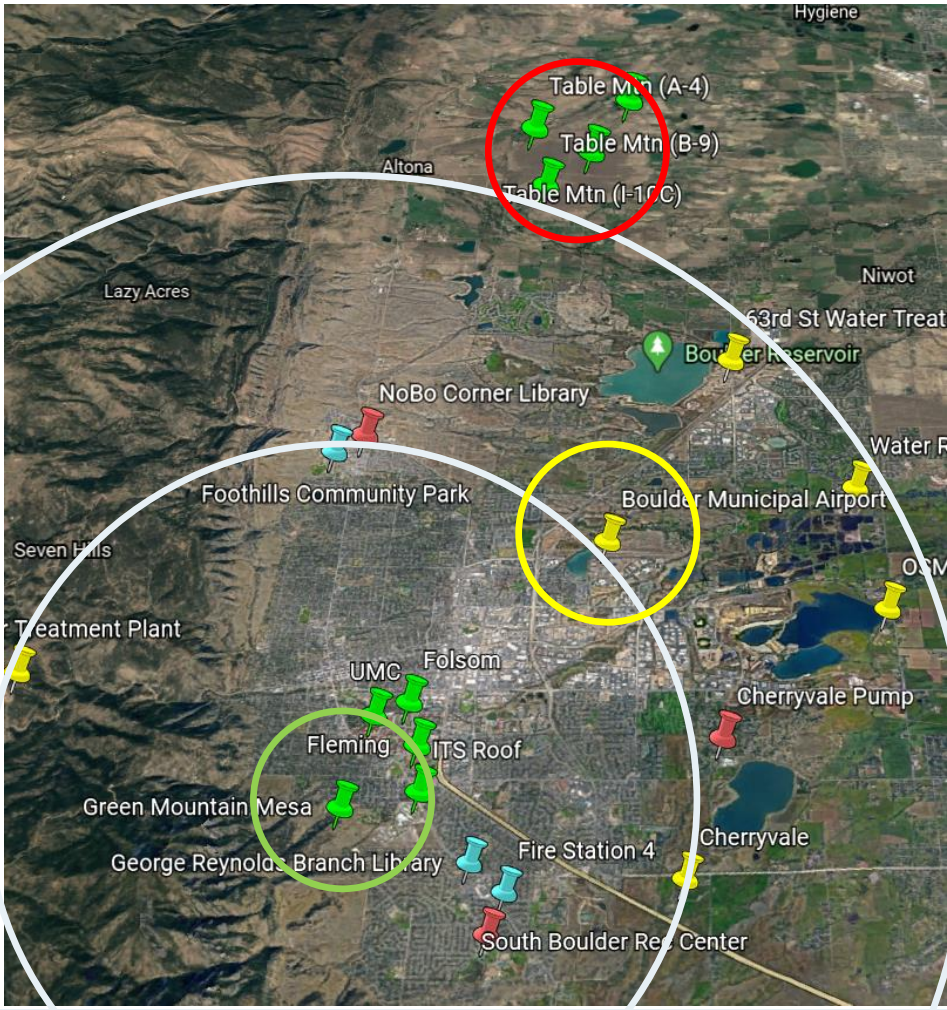


Future of Spectrum Monitoring

- Monitoring paradigm shift
- Real-world development/test
- Distributed, persistent, and automated spectrum monitoring
  - Heterogeneous sensors
  - Standardized and open source software
  - Common metadata
  - Automation for security and scalability

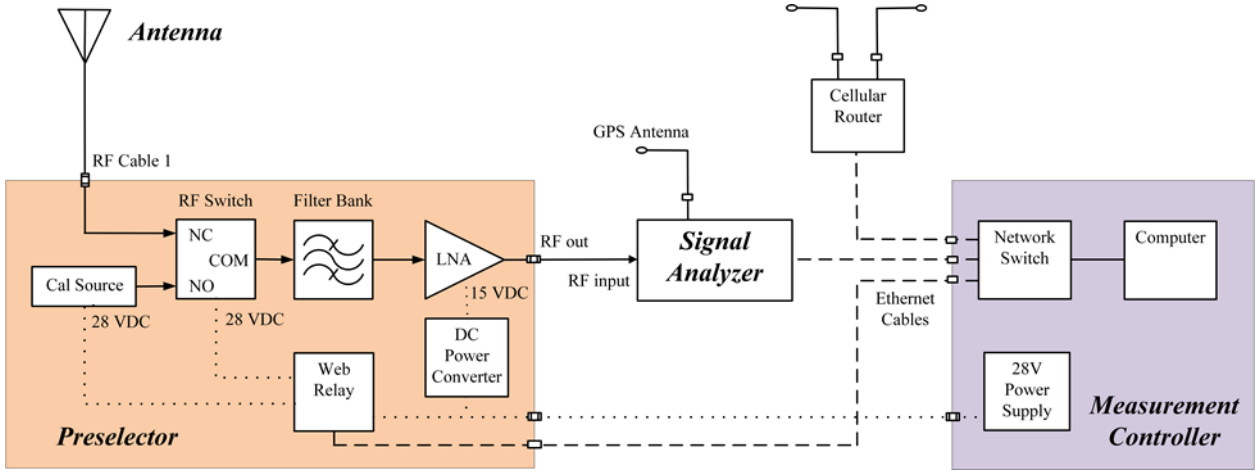
Boulder Wireless Test City

- Distributed sensors throughout Boulder and ITS Table Mountain Field Site and Radio Quiet Zone
- Variety of propagation environments
- Diverse spectrum activity
- Ongoing Cooperative agreement with CU to deploy RF sensors throughout campus
- Actively working additional deployments and fiber access with Boulder Research and Administrative Network (BRAN)
- Spectrum Occupancy and Characterization Sensing (SCOS) software

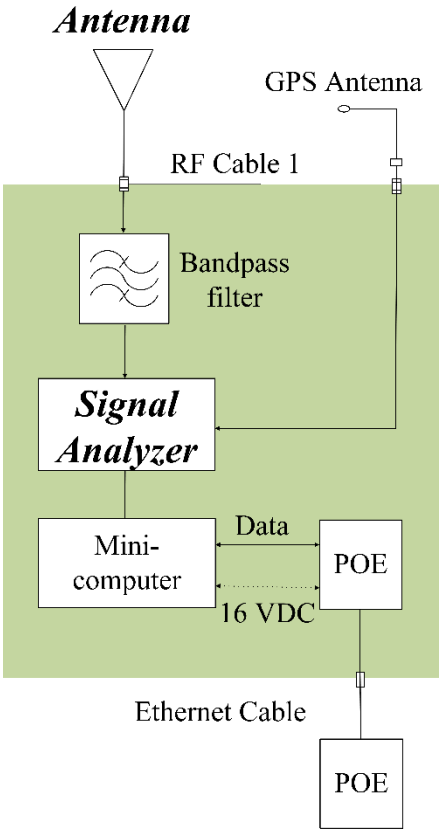


Heterogeneous Sensing

- Customize to mission
- Reduce cost to scale when necessary
- COTS components
- Interchangeable components + repeatable, automated, rigorous process to go from lab to field



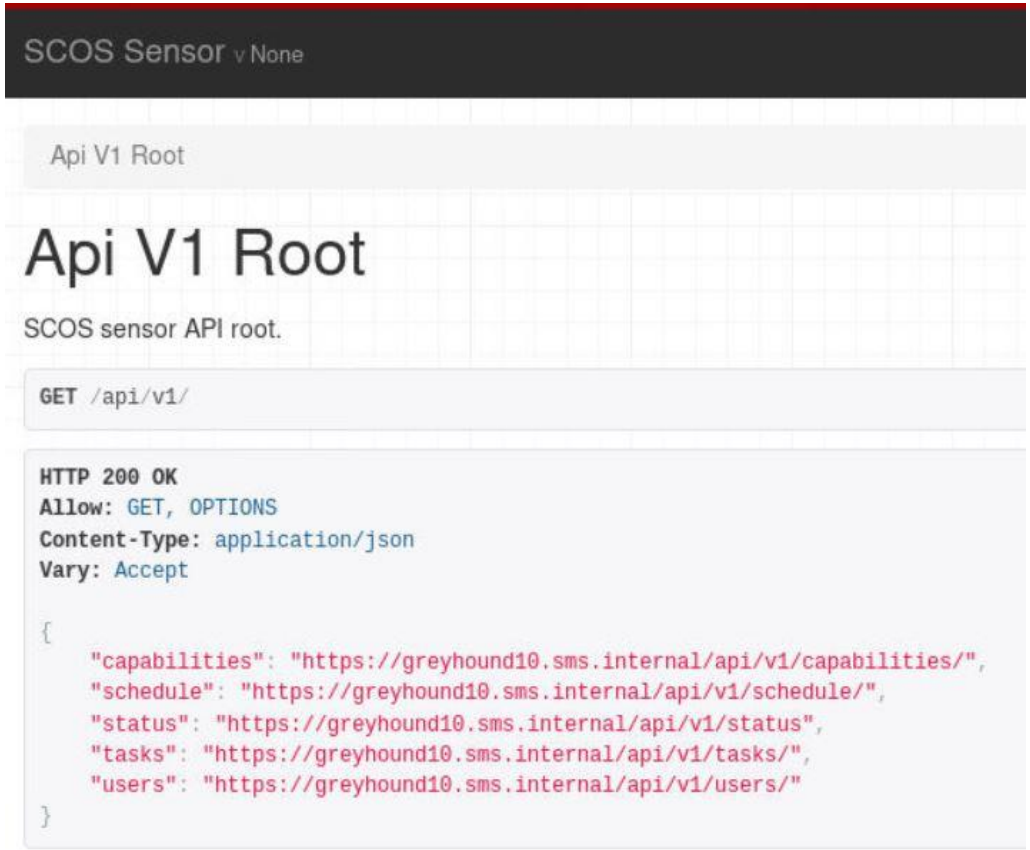
Basset hound sensor (~$25k)



Greyhound sensor (~5k)

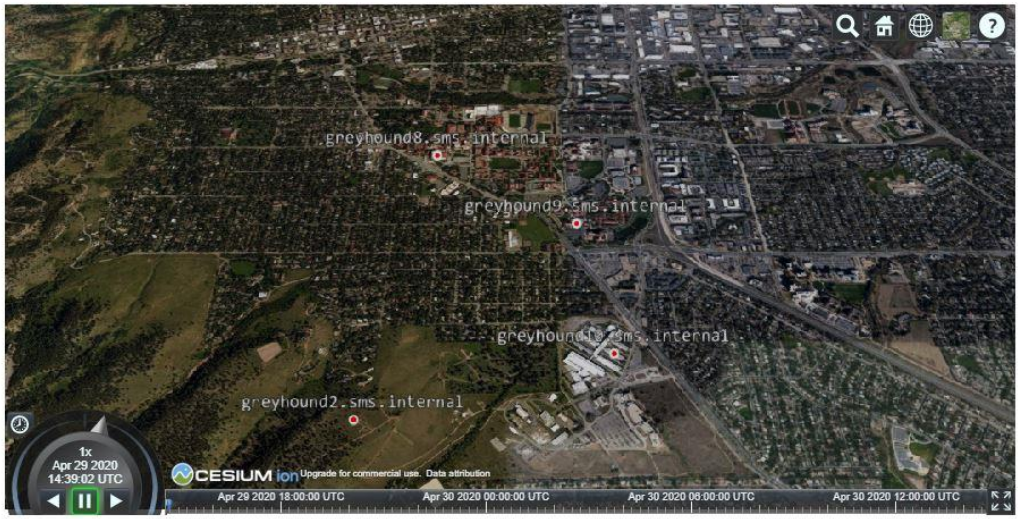
SCOS Sensor

- Application Programming Interface (API) establishes universal language to interact with heterogeneous sensors
- Currently supports 2 commercial SDRs
- Open sourced to allow additional integrations
- Discoverable sensing Actions
  - Edge processing
  - Research transition path
- Onboard scheduler



SCOS Manager

- Centralized command and control for large networks of distributed sensors
  - Manage sensor schedules
  - Search and download archived RF data
  - Analytics and visualization
- Analytics API supports third party integrations
- Secure data service from sensors - NTIA website available for authorized Federal users in 2021 Q1



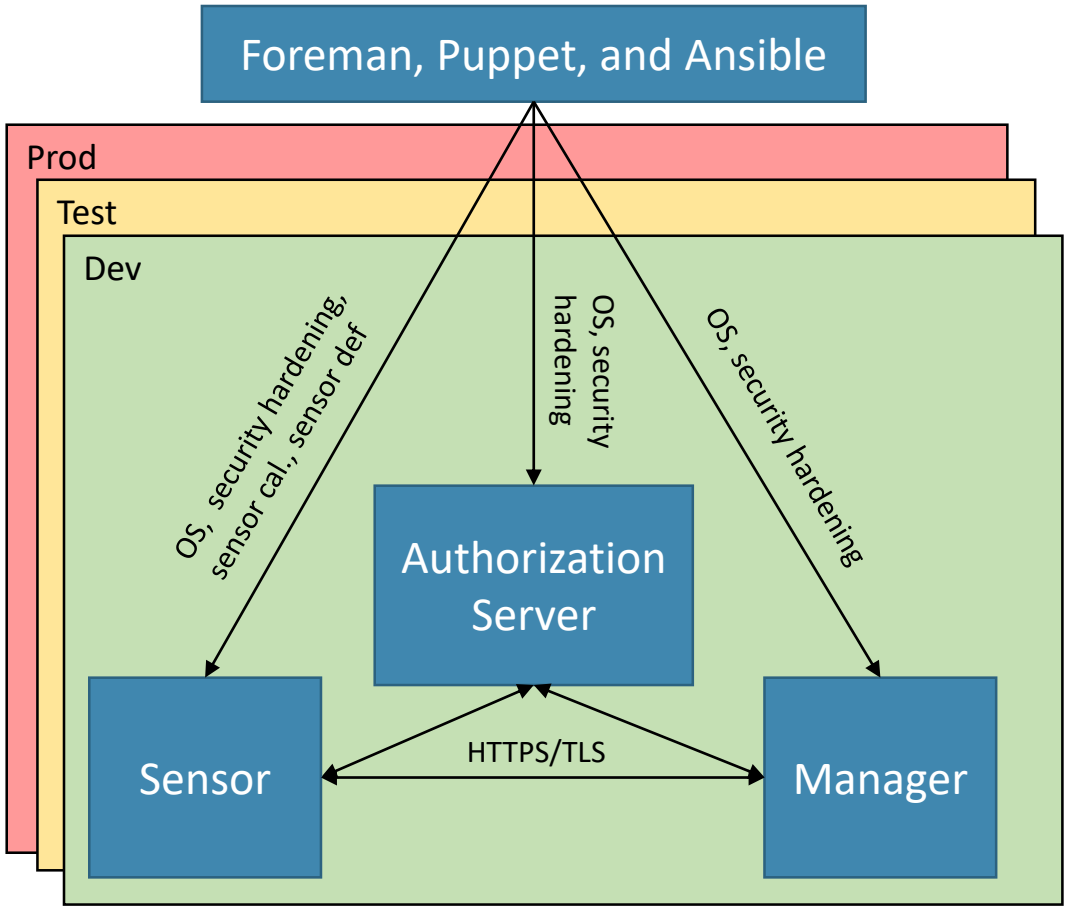
Sensor	Operations
greyhound10.sms.internal	
greyhound2.sms.internal	
greyhound5.sms.internal	
greyhound8.sms.internal	
greyhound9.sms.internal	

Interoperability and Reusability

- Break down silos by encouraging interoperability and reusability
  - IEEE 802.15.22.3 standardization
  - Open source common metadata
- 9 SigMF Extensions in sigmf-ns-ntia in public GitHub repo
  - `ntia-core` adds generally useful metadata fields
  - `ntia-sensor` defines hardware components and settings
  - `ntia-algorithm` describes the measurement performed (detectors, algorithms, etc)
  - `ntia-calibration` provides information about calibration factors applied to the data
  - `ntia-emitter` gives information about the emitter being measured
  - `ntia-location` gives information about the types of coordinate systems used in the metadata.
  - `ntia-environment` gives information about the environment around a sensor or emitter
  - `ntia-waveform` provides metadata to describe measured or transmitted waveforms
  - `ntia-scos` provides metadata for the NTIA Spectrum Characterization and Occupancy Sensing (SCOS) implementation

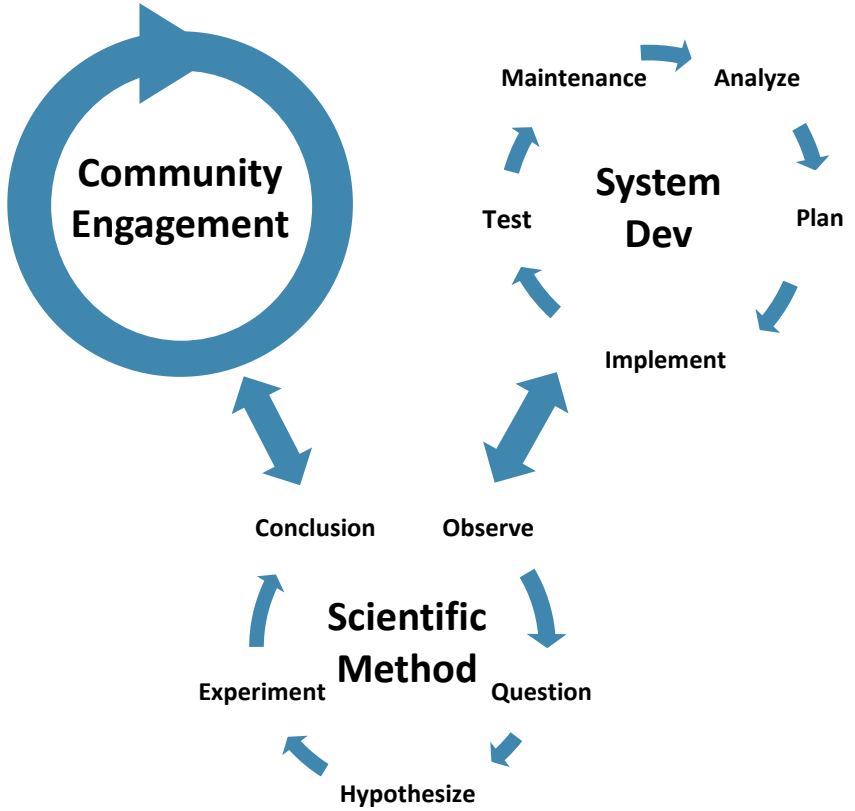
Scalability and Security

- Automation
  - Automated provisioning and maintenance
  - Foreman – Operating System (OS) deployment and status/monitoring
  - Puppet – dev/test/prod environments support technology evolution and experimentation
  - Automated software updates
- Confidentiality & Integrity
  - NIST Special Publication 800-53 security controls
  - Ansible automated security hardening of edge devices
  - Calibration and sensor definition files characterize every sensor
  - Provide metadata with every acquisition
  - Lab verification and configuration management of sensing actions



Conclusion: Local Research National Impact

- Edge processing
- Coordinated sensing
- Characterize RF environment
  - Broadband survey
  - Band occupancy measurements
  - Noise floor measurements
  - Spectrum map
- Propagation model development & validation
- Compliance and usage validation
- Enforcement methods
  - Anomaly/Interference detection
  - Classification
  - Geolocation
  - Reporting, Notification, and Mitigation



Partnering with industry, academia, and other Federal agencies in the development of advanced spectrum monitoring technologies

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